Face Recognition 101
The Technology and Its Applications

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Face (facial) recognition is the identification of humans by the unique characteristics of their faces and is one of several types of biometric systems[2]. In general, biometric devices can be explained with a three-step procedure.

1. A sensor takes an observation. The type of sensor and its observation depend on the type of biometrics device used. This observation gives us a "Biometric Signature" of the individual.

2. A computer algorithm "normalizes" the biometric signature so that it is in the same format (size, resolution, view, etc.) as the signatures on the system's database. The normalization of the biometric signature gives us a "Normalized Signature" of the individual.

3. A matcher compares the normalized signature with the set (or sub-set) of normalized signatures on the system's database and provides a "similarity score" that compares the individual's normalized signature with each signature in the database set (or sub-set). What is then done with the similarity scores depends on the biometric system's application.

This Biometric Methodology establishes the analysis framework with tailored algorithms for each type of biometric device. Face recognition starts with a picture, attempting to find a person in the image. This can be accomplished using several methods including movement, skin tones, or blurred human shapes. The face recognition system locates the head and finally the eyes of

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[1] DoD Counterdrug Technology Development Program Office and the National Institute of Justice.

[2] A "biometric system" is an automated method of recognizing someone from their physiological or behavioral characteristics.

the individual. A matrix[3] is then developed based on the characteristics of the individual's face. The method of defining the matrix varies according to the algorithm (the mathematical process used by the computer to perform the comparison). This matrix is then compared to matrices that are in a database and a similarity score is generated for each comparison.

For face recognition, as well as other biometric systems, there are two types of comparisons. The first is verification. This is where the biometric system compares the given individual with who that individual says they are and gives a yes/no decision. The second is identification. This is where the biometric system compares the given individual to all individuals in the database and gives a ranked list of matches.

[3] A "matrix" is a rectangular array of numbers, similar to a numerical version of word search puzzles.

There are numerous applications for face recognition technology:

- Government Use
  - ***Law Enforcement.*** Minimizing victim trauma by narrowing mugshot searches, verifying identify for court records, and comparing school surveillance camera images to known child molesters.
  - ***Security/Counterterrorism.*** Access control, comparing surveillance images to known terrorists.
  - ***Immigration.*** Rapid progression through Customs.
  - ***Legislature.*** Verify identity of Congressmen prior to vote.
  - ***Correctional institutions/prisons.*** Inmate tracking, employee access.

- Commercial Use.
  - ***Day Care.*** Verify identity of individuals picking up the children.
  - ***Missing Children/Runaways.*** Search surveillance images and the internet for missing children and runaways.
  - ***Gaming Industry.*** Find card counters and thieves.
  - ***Residential Security.*** Alert homeowners of approaching personnel.
  - ***Internet, E-commerce.*** Verify identity for Internet purchases.
  - ***Healthcare.*** Minimize fraud by verifying identity.
  - ***Benefit payments.*** Minimize fraud by verifying identity.
  - ***Voter verification***. Minimize fraud by verifying identity.
  - ***Banking.*** Minimize fraud by verifying identity.

Evaluating facial recognition systems is very application-specific. Results from an analysis for a specific application are usually not correct for other applications. Evaluating the technology properly is a difficult task for those that have worked in the field for several years, and is even more difficult for those new to the field. The two papers described below will be of interest to anyone thinking about evaluating facial recognition technology. Both papers, as well as several other documents, are available in the Facial Recognition Vendor Test 2000 Documents section of http://www.dodcounterdrug.com/facialrecognition.

Evaluating Technology Properly - Three Easy Steps to Success. This paper provides an overview of evaluation ideals that should be followed and is presented in a non-technical nature.

Evaluating Facial Recognition Technology for Drug Control Applications. This paper provides an example of how to analyze results from a Technology Evaluation for a specific application.